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CONTENTS

COVER PICTURE

A Brahman X Hereford cow with her Angus sired calf graze Coastal bermudagrass on the Red River Valley Agricultural Experiment Station at Bossier City, La., at weaning time (July 15, 1981). Cow No. 416, shown here, produced and weaned five calves by the age of 7 years. The calves were all sired by Angus bulls, and the average weaning weight of her four heifer and one steer calves was 556 pounds.

Cow Data

Cow No.: 416
Breed: ½ Brahman, ½ Hereford
Age: 7 years
Weight: 1,150 pounds

Calf Data

Calf No.: 113
Breed: ½ Angus, ¼ Brahman, ¼ Hereford
Age: 299 days
Sex: steer
Weaning weight: 660 pounds
Grade: 15 (low fancy)
W.P.D.A.: 2:21 pounds
Calf value: $429

Straightbred and Crossbred Beef Cattle Performance in Louisiana

JOHN W. KNOX,[1] PAUL E. HUMES,[2]
K. L. KOONCE[3] AND D. K. BABCOCK[3]

The primary goal of a cow-calf producer is to have each cow in his herd wean one heavy calf each year. Maximum improvement in reproduction and calf weaning weight probably will come through a combination of improved heredity and environmental factors. Available research indicates that the use of crossbred females in a well planned beef crossbreeding program significantly increases cow reproduction and calf weaning weight.

Information is limited on the performance under southern climatic conditions of the recently introduced Continental European or exotic breeds when crossed with the traditional British breeds. Previous research at the Louisiana Agricultural Experiment Station has demonstrated that firstcross Brahman cows were generally superior to straightbred and other firstcross cows for reproduction and maternal traits. Maternal ability includes milk production, general care, and protection provided by the beef female for development of her calf both before and after birth and up to weaning time. With these facts in mind, a project was initiated on alluvial soils at the Red River Valley Agricultural Experiment Station, Bossier City, to (1) compare the growth performance of Hereford calves with the growth performance of crossbred Brahman and Continental European-sired calves from Hereford dams in the first phase and; (2) to compare in Phase II of the study the maternal performance of the straightbred Hereford with that of crossbred cows produced in Phase I.

EXPERIMENTAL PROCEDURE

Phase I

Cow Herd Management

Hereford cows averaging 6.9 years of age were artificially bred in an estrus synchronization project to produce calves for this study. The base cattle herd had been enrolled in a performance testing program for 15 years prior to the initiation of the study, and all replacement heifers were selected from this herd. Cows were culled for either low reproduction or low calf weaning weights, and the herd was considered to be a highly productive

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commercial herd. Birth and weaning weights were obtained for 233 calves born during three fall calving seasons (1971 through 1973). The calves were produced by artifically breeding Hereford cows with semen from Brahman, Limousin, Maine-Anjou, and Simmental sires. Following the artificial insemination (AI) period, Hereford bulls were placed with the cows for cleanup breeding. Over the 3-year period four to six sires per sire breed were used to produce the calves. Although the Hereford calves were born later in the calving season than AI calves, they were not extremely late calves because Hereford bulls were placed with the cows between the first and second synchronized AI periods as well as after the second AI period.

Difficult calving was not a problem with mature Hereford cows calving Brahman-, Limousin-, Maine-Anjou-, or Simmental-sired calves. A high percentage of 3-year-old first-calf heifers bred to the larger exotic beef breeds, however, were assisted at calving.

The cows were bred during a 75-day breeding season from December 5 to February 20 to calve between September 15 and December 1. The dams were approximately 36 months of age when they first calved. All male calves were castrated at birth. The calves did not receive any creep feed and remained with their dams until weaned at an average age of 270 days. Each year cow and calf weights were recorded on December 1, April 1, and July 15, and the calves were graded by the same Louisiana Cooperative Extension Service Beef Specialist at each July 15 weaning date.

All calves were vaccinated with a seven-way vaccine for blackleg and other clostridial diseases. Brood cows were vaccinated annually for vibriosis and leptospirosis and each cow received an injection of Vitamin A prior to the breeding season. Cows were wormed twice in the fall and twice in the spring, 14 to 21 days apart, to control internal parasites. The calves were wormed once when they were approximately 6 months old. External parasites on the cows and calves were controlled by spraying or dusting as needed.

The cows were stocked at the rate of approximately one cow per acre throughout the study. During the fall calving season the cows grazed Coastal bermudagrass pastures with additional Coastal hay and protein supplement supplied as needed during the late fall and early winter. During the winter and spring the cows and calves grazed pastures containing either a wheat-ryegrass mixture planted on a prepared seed bed, or fescue-Sl clover mixtures, or sod planted ryegrass on Coastal bermudagrass pasture. High quality Coastal bermudagrass and sorghum-sudangrass pastures were provided for the cows and calves during the summer up to the time of weaning on July 15. All pastures were highly fertilized in split applications and any excess forage was harvested for hay.

Postweaning Management

Postweaning data were obtained for 233 steers and heifers weaned during the 3 years of Phase I (1972 through 1974). Following a 2-week weaning adjustment, the calves were placed together in one group and allowed to graze sorghum-sundangrass pastures beginning August 1 each year and then rotated to Coastal bermudagrass pastures. The steers and heifers continued to graze Coastal bermudagrass pastures during the late fall, and hay was fed as needed until winter pastures were available for grazing, usually in early January. Yearling steers and heifers were grazed on wheat-ryegrass pastures throughout the winter and spring. The yearlings grazed the second summer and early fall on Coastal bermudagrass and sorghum-sudangrass pastures. The animals did not receive any supplemental protein or grain during any of the grazing period. This type of management grazing system continued three consecutive grazing seasons (1972 to 1975). The stocking rate throughout the postweaning phase was approximately two head per acre.

Postweaning weights were recorded as initial weights 2 weeks after weaning and as final weights when the animals were long yearlings. Intermediate weights were also obtained after each seasonal (summer or winter) grazing period.

All weights were recorded using the same weighing conditions and the animals remained in one group throughout each of the 3 grazing years. The steers were not implanted with a growth promotant, but both steers and heifers were wormed once in the fall and once in the spring each year. External parasites were controlled by spraying or dusting as needed.

Year one ages when yearling and long yearling weights were obtained differed from the ages at weighing times in years two and three. In year one average yearling and long yearling ages were 348 and 581 days, respectively. In years two and three average yearling and long yearling ages were 397 and 683 days, respectively.

Phase II

The Brahman x Hereford, Limousin x Hereford, Maine-Anjou x Hereford, Simmental x Hereford, and straightbred Hereford cows, produced in Phase I, were used in the 4-year study of Phase II. Each year heifers and mature cows were bred to performance tested Angus bulls, highly selected for growth rate, during a 75-day breeding season from early December to mid-February to calve between September 15 and December 1 of the subsequent year. Performance data were obtained on 325 Angus sired two and three way cross calves born during four fall-calving seasons (1975 through 1978). The cows ranged in age at calving from 3 to 7 years

and were divided into single sire breeding groups of 25 to 30 cows during the breeding season. Each of the different breed types was represented in all sire breeding groups. After the breeding season all cows were maintained in a single herd.

The cows used in Phase II were managed similarly to those in Phase I with regard to pastures, supplemental feeding, stocking rates, pasture fertilization and herd health practices. Cow and calf weights were also recorded as in Phase I. Calves were again weaned on July 15 each year at an average age of 274 days. Calves were not creep fed because it would interfere with maternal evaluation of the dam breeds. All calves were individually priced by the same auction barn manager each year and graded by a beef specialist at weaning time.

Statistical Analysis

The data were statistically analyzed by least-squares procedures. Because yearling and long yearling ages varied from year to year in Phase I, the effects of variation in calf age were removed in a preliminary analysis. The detailed mathematical models employed are outlined in the appendix.

RESULTS AND DISCUSSION

Calf Growth, Phase I

Results of Phase I are presented in Table 1. Year differences were important ($P<.01$) for weaning and postweaning growth traits, but differences did not occur for birth weight. Birth weights varied from a low of 74.6 pounds in 1974 to a high of 75.2 pounds in 1973. This small variation in birth weight suggests that the in-utero environment provided to the fetus was adequate to offset any yearly variations that existed in forage quality and climatic conditions. Variations observed in calf weaning weight, yearling weight and long yearling weight are typical of yearly differences that exist in beef operations.

Table 1.—Least Squares Year Means and Standard Errors for Growth Traits, Phase I

Year	No. of calves	Weight, lbs.			
		Birth	Weaning**	Yearling**	Long yearling**
1972	84	74.9±1.2	475.2±8.2	549.8± 9.1	803.6±9.5
1973	83	75.2±1.3	465.3±8.8	562.7± 9.3	794.5±9.7
1974	66	74.6±1.4	434.0±9.4	518.7±10.5	756.9±10.9

**Significant year differences, $P<.01$.

Breed-of-calf differences (Table 2) were quite pronounced ($P<.01$) for weights of the calves at all ages and include both breed and mating type (straightbred and crossbred) influences. Straightbred Herefords were smaller than any of the crossbred groups at birth and all subsequent ages. Brahman-sired crossbreds performed similarly to the average of the three Continental European-sired crossbred groups (Limousin, Maine-Anjou and Simmental) through weaning. Subsequently they had higher growth performance than any of the other crossbred groups. This is depicted graphically in Figure 1. The superior postweaning performance of Brahman crossbred cattle on forage diets has been observed consistently at this location and at other experiment stations throughout Louisiana.

Table 2.—Least Squares Calf Breeding Means and Standard Errors for Growth Traits, Phase I

Calf Breeding	No. of calves	Weight, lbs.			
		Birth**	Weaning**	Yearling**	Long yearling**
H	108	65.9± .9	411.5± 6.8	497.9± 6.6	725.3± 6.9
BxH	33	76.5±1.7	470.4±10.7	593.1±12.2	838.6±12.6
LxH	44	75.4±1.5	451.0±10.4	532.3±11.3	768.8±11.7
MAxH	26	78.7±2.0	484.8±14.1	542.9±14.8	804.9±15.4
SxH	22	77.9±2.1	473.1±14.7	552.5±15.6	787.3±16.2

[a]Breeds are coded: H= Hereford; BxH = Brahmon x Hereford; LxH = Limousin x Hereford; MAxH = Maine-Anjou x Hereford; SxH = Simmental x Hereford.

**Significant calf breeding differences, $P<.01$.

Among the Continental-sired crossbred groups, Maine-Anjou calves were the heaviest at all ages except at a year of age when the Simmental crosses weighed the most. Williamson and Humes (1980) reported on a study conducted in south Louisiana in which Brahman, Chianina, Maine-Anjou and Simmental bulls were bred to Angus and Hereford cows. In their study no breed-of-sire differences were detected for weaning weight, but the Braham sired calves were 11 and 12 pounds heavier than Maine-Anjou and Simmental sired calves, respectively. From the results of these two studies it would appear that any additive genetic superiority for preweaning growth of the Continental breeds may be offset by greater levels of heterosis of the Brahman crosses in Louisiana environments.

While weights at given ages are very important in determing economic merit of various breeds and breed crosses, weight gains during various stages of growth are also important. For example, growth from birth to weaning is of primary importance to the cow-calf producer whereas postweaning growth is of major interest to the producers in the stocker phase of

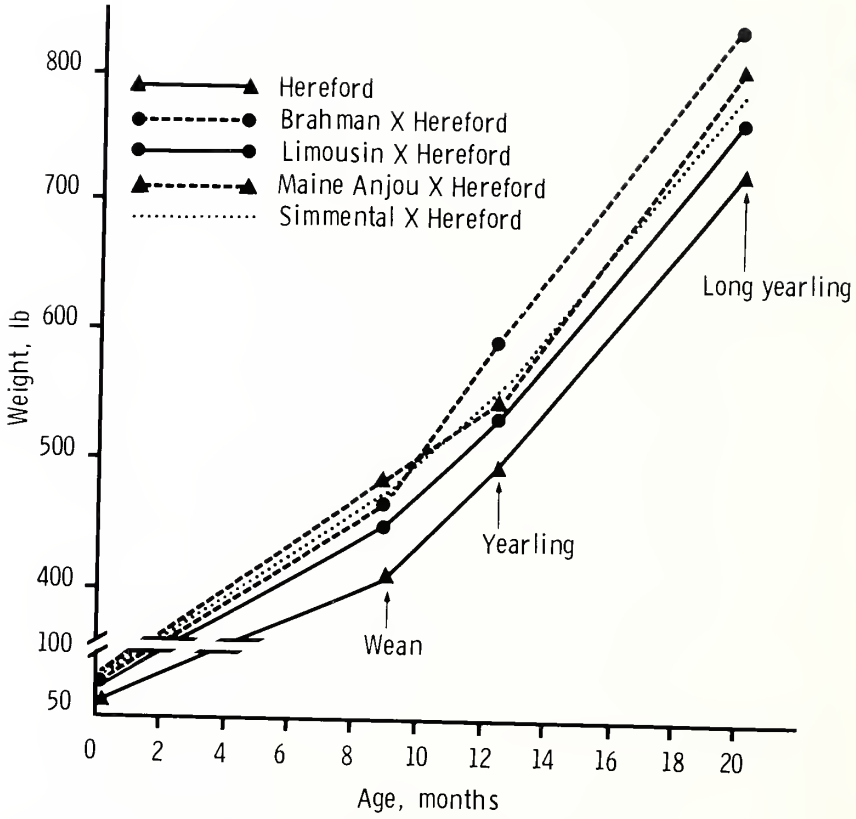

Figure 1.—Growth of Phase 1 calves by breeding of calf.

beef production. Therefore, weight gains for various periods were calculated and are presented in Table 3. Weight gains from birth to weaning were similar for the Brahman, Maine-Anjou and Simmental crosses, with the Limousin crosses being intermediate between straightbred Herefords and other crossbred groups. In the postweaning phase, the most striking observation was the superior performance of the Brahman crosses from weaning to a year of age. This interval occurred from mid-summer to fall when forage quality was at its lowest and vividly demonstrates an adaptive advantage for the Brahman crosses at this time. Also, heat stress, at its highest in July, August and September, may have been a contributing factor. Most of the postweaning weight advantage of Brahman crosses was generated during this period as their weight gains through the winter and subsequent summer were similar to the gains of other breed crosses.

Table 3.—Weight Gains for Various Stages of Growth in Hereford and Crossbred Cattle, Phase I

Colf breed[a]	Birth to weoning, lbs.[b]	Weaning to yeorling wt., lbs.	Yearling wt. to long yeorling wt., lbs.	Total postweaning goin, lbs.
H	345.6	86.4	227.4	313.8
BxH	393.9	122.7	245.5	368.2
LxH	375.6	81.3	236.5	317.8
MAxH	406.1	58.1	262.0	320.1
SxH	395.2	79.4	234.8	314.2

[a]Breeds ore coded: H= Hereford; BxH = Brohmon x Hereford; LxH = Limousin x Hereford; MAxH = Moine-Anjou x Herefard; SxH = Simmental x Hereford.

[b]Obtained by subtracting birth weight from weoning weight for eoch breed group.

In this study, Hereford cattle grew at approximately the same rate following weaning as the Continental-sired crosses. While calves sired by large, growthy breeds might be expected to outgain British breed cattle, such was not the case in this study. Had the cattle been placed in a feedlot following weaning, perhaps the large-framed Continental-sired calves would have had higher growth rates than the straightbred Herefords. With rising grain prices, this does not seem to be an economical system of beef production. Based on these results a stocker operator might observe little, if any, increase in postweaning gains from the large-framed Continental crosses greater than gains for Hereford or Hereford x Angus calves.

Crossbred superiority at weaning appears to be the result of a combination of factors, including heavier birth weights, hybrid vigor (heterosis) and superior early growth. It has been well established that larger birth weights are associated with higher growth rate, particularly from birth to weaning. Of the 58.3-pound weaning advantage of the crossbred calves over the Herefords, 11.2 pounds (19.2 percent) reflected birth weight differences. The large crossbred calves were probably more aggressive in their nursing habits which would tend to magnify the birth effect. Although it was not possible to estimate heterosis in this study, it has been observed

repeatedly for weaning weight in designed crossbreeding studies. In a review article of crossbreeding studies from Nebraska, Cundiff (1975) reported that crossbred calves exhibited an average advantage of 19.4 pounds (4.6 percent heterosis) over the purebreds. Crossbred calves were also 2.7 pounds heavier at birth than the purebreds. Turner and McDonald (1972), reporting the results of a crossbreeding experiment involving Angus, Brahman, Brangus and Hereford cattle at LSU, observed that singlecross steer and heifer calves were 41.6 and 35.0 pounds heavier, respectively than their straightbred contemporaries.

Cow Production, Phase II

In Phase II, year differences were quite large ($P<.01$) for percent calf crop born and weaned (Table 4). These differences reflect how climatic and nutritional differences markedly affected reproduction and calf livability in this cow herd. The highest percent calf crop born occurred in the fall of 1976 and 1977 following the mild winters of 1975 and 1976 when the cows were bred. In the fourth year of the study (1977 breeding season and 1978 calving season) much more severe weather was encountered, particularly during the breeding season from December to mid-February which resulted in a greatly reduced conception rate.

Table 4.—Least Squares Means and Standard Errors for Percent Calf Crop Born and Weaned By Year, Phase II

Yeor	No. of Cow exposures	Percent calf crop ± S.E.	
		Born**	Weoned**
1975	63	80.9±5.3	77.7±6.0
1976	95	91.9±4.2	86.2±4.8
1977	119	88.8±4.0	85.3±4.6
1978	131	71.0±4.6	67.1±5.3

**Significont yeor differences, $P<.01$.

As presented in Table 5, large year differences ($P<.01$) were observed for all calf traits except birth date. Significant year to year variation ($P<.01$) was also observed in cow weight at weaning. As evidenced by the heavier calf and cow weights, the 1975-1976 and 1976-1977 grazing seasons were decidedly superior to the last 2 years for fall-calving cows in north Louisiana. The abnormally cold weather encountered for long periods severely retarded the growth of winter pastures until early spring in 1977-1978 and 1978-1979 which had an unusually depressing effect on cow and calf weights at this location. The variation of 135 pounds in calf weaning weight from the best to poorest year is a much larger difference than normally expected, but it is indicative of the climatic extremes encountered in this particular 4-year period in north Louisiana.

Table 5.—Least Squares Means and Standard Errors for Cow Production and Weight By Year, Phase II

Year[a]	No. of calves	Birth date, day[b]	Birth** wt., lbs.	Wean** wt., lbs.	Calf grade	July cow** wt., lbs.
1976	49	285.6±4.6	68.9±1.7	556.3±9.0	12.5±.2	1106.5±15.1
1977	79	291.2±3.4	74.0±1.3	533.7±6.6	12.3±.1	1115.5±11.0
1978	106	282.7±3.3	71.6±1.2	467.3±6.5	11.7±.1	1013.6±10.9
1979	91	281.1±4.6	67.1±1.7	431.6±9.1	11.9±.2	976.3±15.3

[a]Denates year when weaning accurred; e.g., colves barn in the fall of 1975 were weaned in the summer of 1976.

[b]Based an the Julian birthdate, counting January 1 as day ane.

**Significont year differences, P<.01.

Cow breed differences were not significant for either measure of cow reproduction (Table 6). The percent calf crop born was very similar for all groups except the Maine-Anjou x Hereford cows which had the lowest calving rate (76.4 percent). For weaning rate, Simmental x Hereford cows showed a slight superiority because no calf losses from birth to weaning occurred in this group. Calf losses from birth to weaning were similar for the Limousin x Hereford (7.9 percent), Hereford (7.8 percent) and Brahman x Hereford cows (8.0 percent).

Table 6.—Least Squares Means and Standard Errors for Percent Calf Crop Born and Weaned By Cow Breed, Phase II

Cow breed	No. of Caw exposures	Percent colf crop ± S.E.	
		Born	Weaned
Hereford	137	85.9±3.0	78.1±3.4
Brohmon x Hereford	138	85.0±3.9	77.0±4.5
Limousin x Hereford	66	84.1±4.3	76.2±4.9
Moine-Anjou x Hereford	33	76.4±6.1	73.7±6.9
Simmentol x Herefard	34	84.3±6.0	84.0±6.8

The lack of superiority of the crossbred cows over the Hereford cows for reproduction and calf livability is not consistent with most crossbreeding studies. Turner *et al.* (1968) reported large levels of heterosis for reproduction in crosses of Angus, Brahman, Brangus and Hereford cattle. Of the 12 crossbred cow groups in their study, all except the Angus x Brangus cross had higher reproductive rates than the average of their respective purebred contemporaries. Calving rates of 84.7 percent and 65.6 percent were reported for Brahman x Hereford and Hereford dams, respectively. In their study the cows calved in the spring rather than in the fall which may have accounted partially for the low reproduction of the Hereford cows. In another study reported by Meade *et al.* (1981), significant breed-of-dam

differences were obtained for calving rate in a spring calving herd. Brahman crosses had the highest calving rate (76.4 percent) followed by Maine-Anjou (71.6 percent), Simmental (62.8 percent) and Chianina (62.5 percent) crosses. Results of these studies, all conducted in Louisiana, suggest that purebred Hereford and crossbred Simmental cows may have relatively high reproductive rates in fall calving herds but may be inferior to crossbred Brahman cows in spring calving herds.

Cow breed differences were observed in calf weaning weight and calf grade at weaning, but no differences were observed in birth date (calving date) or birth weight (Table 7). Although mean birth dates appear to vary considerably from group to group (day 278.6 to day 293.6), the large amount of variation observed within each breed group prevented the differences in birth date from being statistically significant. Generally crossbred Brahman cows calved later which might be expected since the Brahman breed is noted for having a longer gestation period than most *Bos taurus* (non-humped) beef breeds.

Brahman x Hereford cows weaned the heaviest calves in every year except 1976 when the Simmental x Hereford cows ranked first. Averaged across years the Simmental x Hereford cows ranked second and the Hereford cows weaned the lightest calves each year. Performance of the Limousin and Maine-Anjou crosses were similar and intermediate between the straightbred Herefords and crossbred Simmentals for calf weaning weight.

Table 7.—Least Squares Means and Standard Errors for Cow Birth and Weaning Production Traits by Cow Breed, Phase II

Cow breed[a]	No. of calves	Birth date, day[b]	Birth wt., lbs.	Wean** wt., lbs.	ADG** April-July	Calf grade**
H	106	283.4±2.6	69.3±1.0	444.1± 3.0	1.47±.03	11.4±.1
BxH	114	293.6±3.5	71.6±1.3	541.9± 6.8	1.65±.03	12.8±.1
LxH	53	285.3±3.7	69.3±1.4	487.2± 7.3	1.60±.04	12.0±.2
MAxH	25	278.6±5.7	68.6±2.1	487.5±11.1	1.57±.06	12.1±.2
SxH	27	284.8±5.1	73.1±1.9	525.4±10.0	1.83±.05	12.2±.2

[a]Breeds are coded: H= Hereford; BxH = Brahman x Hereford; LxH = Limousin x Hereford; MAxH = Maine-Anjou x Hereford; SxH = Simmental x Hereford.

[b]Based on the Julian birth date, counting January 1 as day one.

**Significant cow breed differences, P<.01.

Breed-of-dam rankings were not consistent across all years as evidenced by the significant year x cow breed interaction. As mentioned earlier, the Brahman crosses ranked first in all years except in the first year of the study. The Hereford cows weaned the lightest weight calves in each year. The Simmental crosses weaned the heaviest calves in 1976, the second heaviest calves in 1977 and 1978 and ranked third in 1979. The Limousin

and Maine-Anjou crosses ranked third or fourth in each year except in 1979 when the Maine Anjou x Hereford cows ranked second ahead of the Simmental crosses. No apparent reason exists as to why the year x breed-of-dam interaction occurred for weaning weight. With the 4 years combined, however, the weaning weight averages should be reasonably representative of the performance of the breeds over several years.

It is generally accepted that differences exist among breeds of cattle in their lactation persistency. Generally beef cows will not lactate as long as dairy cows, and in some instances beef cows will actually cease lactating and wean their calves prior to a normal time for weaning. Because of their dams' lower lactation potential and shorter lactation period, beef calves are frequently weaned at approximately 7 months of age. This is the reason for using the standard 205-day adjusted weaning weights in performance testing programs. In the South where longer growing seasons are available, it is advantageous to allow calves to nurse their dams as long as possible. Therefore, in this study, calves were weighed in April at an average age of 168.8 days and again 105 days later at the July weaning date.

In the last 105 days before weaning, variation among the cow breeds was again observed for calf average daily gain (Table 7). The breeds generally ranked the same as at weaning, except Simmental crosses had higher gains than Brahman crosses. This would suggest that Simmental crosses are more persistent and will lactate longer than the other crosses. Forage quality and quantity is at its peak during these months, which also might explain the superior performance of the Simmental crosses during this season.

For calf grade at weaning, cow breed differences were large ($P<.01$), and breed rankings were the same as for weaning weights. This is not surprising since calf grade was a subjective score, and graders usually tend to score larger calves highers than smaller calves. In most studies where this relationship has been investigated, the correlation between weaning weight and calf grade has been quite large.

Although production per cow is important in breed evaluation studies, it is more important to obtain some measure of biological efficiency taking into account cow size. Cow weights and measures of weaning efficiency are presented in Table 8. Large differences ($P<.01$) in cow weights were observed among the breed groups and ranged from a high of 1,102 pounds for Maine-Anjou crosses to a low of 963 pounds for Hereford cows, a difference of 139 pounds.

The measure of pounds of calf per pound of cow weaning a calf was obtained by dividing calf weaning weight by cow weight. Highly significant breed differences were obtained for this measure, and the breeds ranked in the same order as for weaning weight except the Maine-Anjoy crosses dropped from third to last (Table 8). This was partially the result of the large size of these cows which caused the low efficiency of .44 pound of

calf weaned per pound of cow weaning a calf.

Herd efficiency, measured in pounds of calf weaned per pound of cow maintained in the herd, is calculated by multiplying percent calf crop weaned by the pounds of calf weaned per pound of cow weaning a calf. This measure was not subjected to a statistical analysis, but it would appear that the Simmental and Brahman crosses were the most efficient followed by the Hereford, Limousin x Hereford and Maine-Anjou x Hereford crosses, in that order.

Table 8.—Weaning Efficiency by Cow Breed, Phase II

		Lb. of calf per lb. cow		Dollar return per		
Cow breed[a]	July** cow wt.	Weaning** a calf	Maintained in herd[b]	Cow weaning** a calf	Cow maintained[b]	1,000 lbs. of cow maintained[b]
H	963	.462	.361	229.56	179.29	186.17
BxH	1,081	.504	.388	270.37	208.18	192.59
LxH	1,036	.472	.360	239.01	182.13	175.80
MAxH	1,102	.444	.327	246.18	181.43	164.60
SxH	1,083	.487	.409	253.82	213.21	196.87

[a]Breeds are coded: H= Hereford; BxH = Brahman x Hereford; LxH = Limousin x Hereford; MAxH = Maine-Anjou x Herefard; SxH = Simmental x Herefard.

[b]Nat subjected ta statistical anolysis.

**Significant caw breed differences, $P<.01$.

Cash return per cow is also an important measure of efficiency. It is determined by the quantity and quality of the calf produced. On the basis of return per cow weaning a calf, the Brahman x Hereford crosses returned $16.55 more than the second ranked Simmental x Hereford cows and $40.81 more than Hereford cows. When cow size and reproduction differences were accounted for, however, the magnitude of the differences and breed rankings changed markedly. If cash return is expressed on the basis of a 1,000-pound cow maintained in the herd, the Brahman and Simmental crosses were similar in dollar return. The Brahman x Hereford cows produced heavier calves, but this advantage was offset by the higher weaning rate of the Simmental x Hereford cows. Suprisingly, Hereford cows were intermediate in overall efficiency when expressed as pounds of calf weaned or dollar returned per unit cow weight maintained in the herd. This resulted because of the small cow size and high weaning rate of the Herefords compared to the Limousin and Maine-Anjou crosses.

Results of the present study confirm the production advantages of crossbred Brahman cows reported by Turner and McDonald, 1972 and Meade *et al.*, 1981, although the latter authors reported a larger difference in calf weaning weight between Brahman and Simmental crosses (465.4 *vs.* 402.2 pounds) than was observed in this study. Again, this may be

explained partially by the fact that the cows calved in the spring in the study reported by Meade *et al.* (1981) compared with the cows that calved in the fall in this study.

SUMMARY

A two-phase crossbreeding study was conducted over a 9-year period to compare the growth performance of Hereford, Brahman x Hereford, Limousin x Hereford, Maine-Anjou x Hereford and Simmental x Hereford calves and to evaluate maternal performance of the heifers produced in the first phase of the experiment. Crossbred calves produced in the first phase were heavier than Hereford calves at all weighing periods from birth through the long yearling weight. The crossbreds were 17.0 percent heavier at birth, 14.2 percent heavier at weaning, 11.5 percent larger at a year of age and 10.3 percent larger at the long yearling weight than the Hereford calves. Most of the crossbred advantage was manifested at weaning time except in Brahman x Hereford calves. Subsequent gains of Herefords and the three Continental European crossbred groups were quite similar, however postweaning gains of the Brahman crosses excelled all breed groups, particularly from weaning to a year of age. This period coincided with the hottest season of the year from mid-summer to fall when forage quality was at its lowest. Results of the first phase of this study suggest that a producer could realize an increase of from 40 to 75 pounds at weaning and from 45 to 115 pounds at the long yearling weight by producing crossbred calves compared with producing straightbred Hereford calves.

In Phase II of the study, the heifers from Phase I were bred to Angus bulls to produce singlecross and three-breed cross calves over a 4-year period. No significant cow breed differences were detected for percent calf crop born or weaned. Large cow breed differences were observed, however, for cow weight, calf weaning weight, calf grade, pounds of calf weaned per cow weaning a calf and cash return per cow weaning a calf. All crossbred cow groups weaned heavier and higher scoring calves than the Hereford cows. The Brahman crosses ranked first for weaning weight and calf grade followed closely by the Simmental crosses with the Limousin and Maine-Anjou crosses ranked intermediate between the Brahman crosses and the Hereford cows. When cow weight and reproduction differences were removed, however, the Hereford cows were more efficient producers than the Limousin and Maine-Anjou crosses. Brahman and Simmental crosses were similar in efficiency per cow maintained in the herd and returned $27.99 and $32.27 more, respectively, per 1,000 pounds of cow maintained than the lowest ranking Maine-Anjou x Hereford cows. This study illustrates the importance of breed selection and utilization of crossbreeding for maximum return per cow.

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Appendix

The data in Phases I and II were statistically analyzed by least squares procedures using the General Linear Models procedure within the Statistical Analysis System (SAS Institute, Cary, NC). The mathematical model for Phase I data included the main effects of year, breed of sire and calf sex and all first order interactions. Cow age was used as a covariable for all traits, and weaning age was included as a covariable for weaning weight. Following weaning, the weighing dates, and hence ages, differed considerably for the first year compared with the second and third years of the study. Therefore the weights were adjusted by linear regression to a common age within year group (year one and years two and three) prior to analysis, and calf age was not included in the final models employed. The average yearling ages were 348 and 397 days and long yearling ages were 581 and 683 days for year one and years two and three, respectively.

Phase II data collected on the females produced in Phase I included 408 breeding records and 325 weaning records. For the cow reproduction data, the mathematical model included the effects of year, cow breed, year x cow breed interaction, and linear regression on cow age. For all other cow and calf traits analyzed in Phase II, the preceding model was used except that calf sex was included as a main effect, and calf age was included as a covariate when appropriate.

The analyses of variance are presented in Appendix Tables 1 through 3.

Appendix Table 1.—Analysis of Variance for Calf Growth Traits, Phase I

Source	df	Mean Squares			
		Birth wt.	Wean wt.	Yearling wt.	Lang yearling wt.
Year (Y)	2	25.6	25,911**	23,468**	28,687**
Breed (B)	4	1,687.3**	36,277**	61,365**	95,082**
Calf Sex	1	2,606.9**	48,462**	66,876**	102,886**
YxB	8	18.5	2,405	6,467	10,061*
YxS	2	373.9**	2,819	5,102	6,247
BxS	4	125.4	7,998	18,783**	16,139*
b (cow age)	1	11.5	84,042**	50,702**	15,458
b (wean age)	1	—	30,268**	—	—
Error	210(209)[a]	87.0	3,610	4,665	5,039

[a]Errar df = 209 far weaning weight anly.
*P<.05, **P<.01.

Appendix Table 2.—Analysis of Variance for Percent Calf Crop Born and Weaned, Phase II

	df	Mean squares	
		Calf crap barn	Calf crap weaned
Year	3	.5512**	.7787**
Cow breed	4	.0599	.0517
Year x Caw breed	12	.2783**	.4995**
b (caw age)	1	.0236	.0998
Errar	387	.1181	.1532

*P<.05, **P=.01.

Appendix Table 3.—Analysis of Variance for Cow and Calf Traits, Phase II

Source	df	Meon squares							
		Birth date[b]	Birth wt.	Wean wt.	ADG April-July	Colf grade	Caw wt.	Lb. calf per cow	Dallar return per caw
Year (Y)	3	917	412**	97,551**	.821**	4.91	158,159**	.0167**	187,064**
Cow breed (B)	4	1,260	126	95,977**	.768**	17.40**	193,440**	.0215**	15,190**
YxB	12	1,220*	157	4,696*	.308**	1.69	8,743	.0035	1,374*
Calf sex	1	1,699	1,986**	115,908**	2.115**	2.46	1,573	.1237**	159,634
b(cow oge)	1	1,478	2	1,830	.173	5.15*	265,401**	.0407**	2,891*
b(colf age)	1	—	—	450,399**	1.103**	60.47**	26,070	.3342**	90,502**
Error	(303)302[a]	672	94	2,555	.066	1.19	7,230	.0033	728

[a]Errar df = 303 far birth date and birth wt. anly.
[b]Based on Julian birth date, counting January 1 as day one.
*P<.05, **P<.01.